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Monitoring Brazilian low-carbon agriculture plan: The potential of remote sensing to detect adoption of selected agricultural practices

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Abstract: In 2010, the Brazilian Government launched the Low-Carbon Agriculture Plan (Plan ABC) to promote adoption of good management practices by farmers and ranchers nationwide (Brazil, 2011). The selected practices included zero-tillage and integrated crop-livestock systems (also known as mixed farming systems) for cereal grains and beef or dairy production. However, the lack of monitoring procedures to evaluate the implementation and communication to policy makers and society in general may limit governance of the Plan ABC. Remote sensing techniques have strong potential to identify and measure the adoption of the selected practices, particularly regarding integrated crop-livestock systems in comparison with continuous pasture or cropland. The synoptic, multispectral and repetitive characteristics of satellites create a collection of data needed to map land management and understand the crop cycle, mainly in larger countries such as Brazil. In order to monitor crop growth along the season and track the change in management practices, a collection of data constructing a time series is needed. This paper aims at analyzing the spectral behavior of integrated croplivestock systems (ICLS) compared to a neighboring native Cerrado forest and a continuous degraded pasture. The study was conducted in the "Capivara Research Farm" of the National Rice and Bean Research Center of the Brazilian Research Corporation - Embrapa, in Santo Antônio de Goiás, Brazil. The climate had a two welldefined season: a dry season from April to October and a rainy season from November to March. The average annual rainfall is 1505 mm. For this study, ten paddocks were selected with areas ranging from 5.3 ha to 13.1 ha between April 2009 and October 2016. The crop rotation consisted of Brachiaria pasture grass (Urochloa Bryzantha) or fallow in the dry season interchangeably with soybean, rainfed rice and maize+brachiaria pasture grass in the rainy season. Grain crops and maize+brachiaria pasture grass were sown using a no-till planter. We used 97 cloud-free NDVI images of Landsat-8 OLI and Landsat-7 ETM sensors for a 2009-2016 time series, acquired monthly (in average), at 30 m spatial resolution. The focus was to use images of both rainy and dry seasons for the identification of crop cycle. For 12 land use types i.e. native forest, degraded pasture and ten different integrated crop-livestock systems, a mean value of the NDVI was calculated in each polygon-paddock. The results showed that sensor spectral response followed the vegetation growth (Figure 1). Sensors were also able to capture mainly the continuous high amount of forest biomass throughout the years with slight responses due to rainy and dry seasons. Sensors also captured the seasonal variations of crops and pastures that follow the rainy/dry seasons. However, integrated crop-livestock systems have a complex temporal behavior, commonly present in a mixed growth of both crop and pasture that is not easy to separate from crop successions. We are using satellite-derived seasonal NDVI metrics in order to separate different land use types particularly grain croppasture system, based on Tong et al (2017). For example, NDVI of the fields under Brachiaria pasture grass maintained at higher values along the season than the cropped fields (Figure 2).

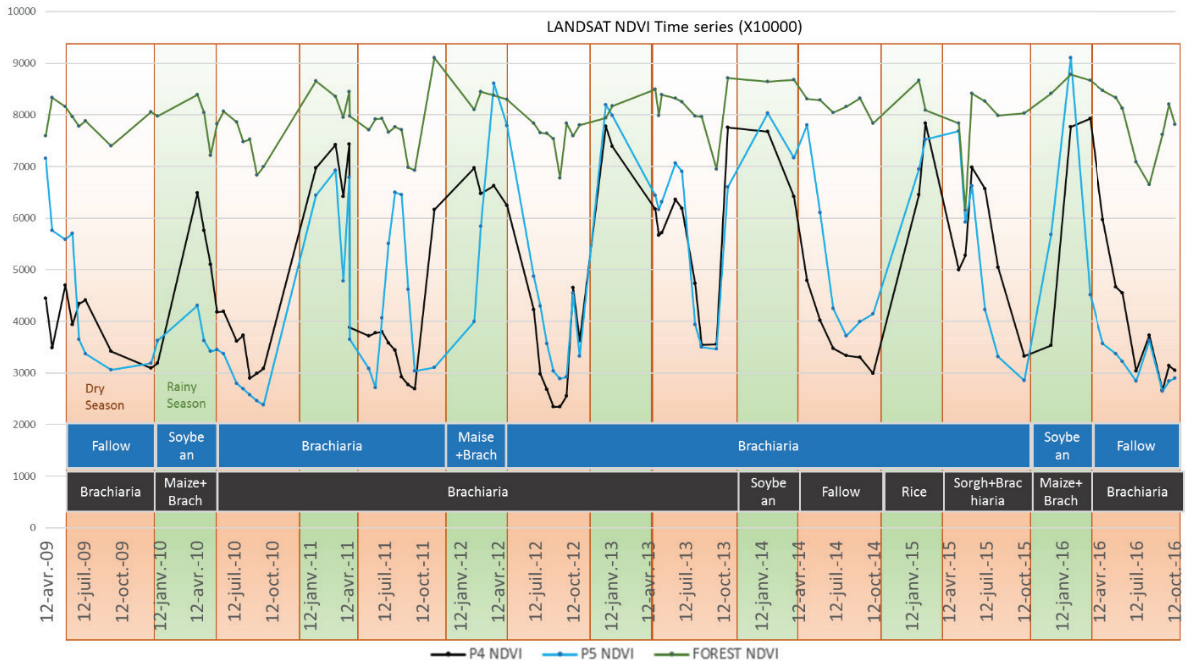

Figure 1 – Landsat NDVI time profile of different land use systems.

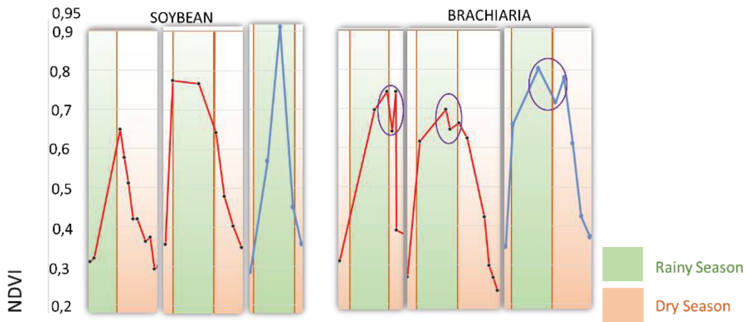

Figure 2. - Patterns of annual NDVI time series for two types of land use (Brachiaria pasture and soybean)

The combination of different imaging systems makes it possible to access cloudless images and take advantage of the spatial, spectral and temporal characteristics of each sensor that will be tested in the future.

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